K2 survey of Ruprecht 147 - the oldest nearby star cluster

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We propose a K2 survey of Ruprecht 147. Long thought to be an asterism, we have recently demonstrated that it is actually the oldest nearby star cluster, with an age of 3 Gyr at a distance of 300 pc (Curtis et al. 2013, AJ, 145, 134). For comparison, the stars in the similarly aged Kepler open cluster NGC 6819 are approximately 70 times fainter, and those in the classic old benchmark M67 are nearly 10 times fainter. This proximity has allowed us to obtain high-resolution spectra for nearly the entire membership, enabling studies of chromospheric activity, lithium depletion, and detailed stellar characterizations; our AO imaging resolves binaries with only 50 AU separations; we can spectroscopically identify and characterize the white dwarfs and red dwarfs; and we can measure coronal X-ray luminosities from Sun-like stars down to the early K dwarfs with Chandra data in-hand.

Ruprecht 147 is located in Sagittarius, and sat just beyond the edge of the proposed field for K2 Campaign 7, until we successfully led a petition for a pointing adjustment to accommodate the cluster. Our proposed K2 survey will provide asteroseismic data for the upper main sequence turnoff and evolved stars. This will yield an independent age constraint for this unique benchmark cluster, based on the stellar masses derived for the red giant branch.

We will measure rotation periods for 3 Gyr FGKM dwarfs. These data are sorely needed for gyrochronology calibration, and will demonstrate the ability of stellar spin down to differentiate between 2.5 Gyr (NGC 6819 Kepler prime), 3 Gyr (R147) and 4 Gyr (M67 campaign 5) ages (Meibom et al. 2015, Nature). R147s proximity allows K2 to provide higher quality data for members of much lower mass than for the distant NGC 6819. Pairing these rotation periods with our chromospheric and coronal X-ray data will provide a comprehensive view of angular momentum and magnetic dynamo evolution at 3 Gyr.

The 8-hour photometric variability signal known as flicker, known to trace stellar density and surface gravity, is also detectable in K2 light curves (Bastien et al. 2013, Nature, 500, 427). We will construct a color-flicker diagram for R147, which will (1) test if K2 flicker measurements properly order the cluster sequence, and therefore produce accurate relative gravities, (2) potentially offer flicker calibration for lower mass stars lacking seismic calibration, and (3) test signal-to-noise dependence, in comparison to a similar color-flicker diagram assembled for M67 from Campaign 5. Calibrating and validating K2 flicker will have broad impact for the entire K2 mission.

Finally, all 1200 astrometric-photometric members will be surveyed for stellar and exoplanetary transits. If any low mass eclipsing binaries are discovered, they could become important touchstones because we also know their ages and compositions. K2 is sensitive to 2 Earth radius exoplanets around FGKM dwarfs in R147.